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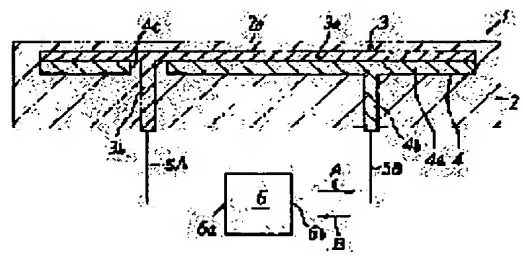
(54) SUSCEPTOR FOR SEMICONDUCTOR WAFER

(57)Abstract:
PURPOSE: To control the temperature of a semiconductor wafer when the temperature fluctuates due to the existence of entrance and exit of heat on the semiconductor wafer, in a susceptor for a semiconductor wafer.
CONSTITUTION: The base material 2 of a susceptor 1 consists of dense ceramics. A thermo-electric conversion element is buried in the base material 2. It is to be desired that this thermo-electric conversion element should consist of a p-type semiconductor element 3 and an n-type semiconductor element 4. The temperature of the semiconductor wafer on an installation face 2a is adjusted by letting a current flow to the thermo-electric conversion element and making it absorb or emit heat.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the susceptor for holding a semi-conductor wafer.
[0002]
[Description of the Prior Art] Processes, such as PVD, CVD, diffusion, and annealing, are carried out in semiconductor fabrication machines and equipment. In this case, a semi-conductor wafer is installed on a susceptor and the single-wafer-processing approach to heat is performed industrially. In case this wafer is heated, carry a semi-conductor wafer on a susceptor and it fixes, or a semi-conductor wafer is adsorbed, it fixes to an electrostatic chuck, and indirect heating is carried out with an infrared lamp. Moreover, this invention person lays the resistance heating element made from a refractory metal underground into a disc-like ceramic base, fixes a semi-conductor wafer to the front face of this base, and exhibits the technique of energizing to a resistance heating element and heating a semi-conductor wafer.
[0003]
[Problem(s) to be Solved by the Invention] However, in the equipment for semi-conductor manufacture, the reaction by the plasma is used more often, and utilization of RIE, PECVD, ECR, etc. is prosperous in recent years. However, with such equipment, the temperature control of a semi-conductor wafer is very difficult.
[0004] For example, in ECR, a process pressure is 10-4torr, and in high vacuum-ization progressing compared with the general spatter, a plasma output is also becoming large. Therefore, heat flows into a semi-conductor wafer rapidly by the bombardment of plasma ion. This heating value is about 1 W/cm2. If it is extent and converts into temperature, it is in 1 minute. Temperature will rise by about 100 degrees C. For this reason, the temperature control of a semi-conductor wafer was impossible.
[0005] As one approach, the coolant is circulated in a susceptor and it is possible to cool a semi-conductor wafer quickly. However, now, supply of the coolant and an excretory system are required, and cannot heat a susceptor to an elevated temperature to coincidence.
[0006] this invention person also examined passing coolant gas to the above-mentioned crevice, when the crevice was prepared on the surface of the susceptor, the semi-conductor wafer was installed on this and the temperature of a semi-conductor wafer rose abruptly. However, if coolant gas is passed, since the degree of vacuum in equipment will fall, a plasma reaction is checked. Moreover, if the heating value supplied to a semi-conductor wafer increases, refrigeration capacity is inadequate and a sudden rise of temperature cannot be stopped.
[0007] In the susceptor for semi-conductor wafers, the technical problem of this invention is enabling it to control the temperature of a semi-conductor wafer, when there are receipts and payments of a heating value on a semi-conductor wafer and temperature is changed.
[0008]
[Means for Solving the Problem] This invention relates to the susceptor for semi-conductor wafers by which the thermoelectric element is laid underground in the base material which consists of substantia-compacta ceramics.

[0009]
[Function] Since the thermoelectric element is laid underground in the base material which consists of substantia-compacta ceramics according to the susceptor of this invention, when there are receipts and payments of a heating value on a semi-conductor wafer, the temperature of a semi-conductor wafer can be controlled by operating a thermoelectric element. If the temperature in a metal or a semi-conductor becomes less uniform [this thermoelectric element] and migration of a carrier will start, it has the function which electric effectiveness, such as the Seebeck effect, a Peltier effect, the Thomson effect, the etching HAUZEN effectiveness, and the Nernst effect, produces.
[0010] And since the thermoelectric element is laid underground in the base material which consists of substantia-compacta ceramics, it is protected from the plasma gas for semi-conductor manufacture, and corrosive gas. Therefore, it continues at a long period of time, and the function which controls the temperature of a semi-conductor wafer is not spoiled. And it can be used satisfactory also under an elevated temperature and a high vacuum.
[0011]
[Example] Drawing 1 is the sectional view showing the susceptor 1 concerning the example of this invention typically. The base material 2 of a susceptor 1 consists of substantia-compacta ceramics. The superficial configuration of a base material 2 is circular, and also may be an ellipse form, a square, etc.
[0012] The thermoelectric element which consists of a P-type semiconductor component 3 and an N-type semiconductor component 4 is laid under the interior of a base material 2. The P-type semiconductor component 3 consists of plate-like section 3a and cylindrical terminal 3b projected from plate-like section 3a. The N-type semiconductor component 4 consists of plate-like section 4a and cylindrical terminal 4b projected from plate-like section 4a. Cylindrical terminal 3b passes along through tube 4c of plate-like section 4a. The end of the cylindrical terminals 3b and 4b is exposed to the tooth back of a susceptor, respectively.
[0013] Cylindrical terminal 3b is connected to the end of cable 5A, and the other end of cable 5A is connected to pole 6a of a power source 6. Cylindrical terminal 4b is connected to the end of cable 5B, and the other end of cable 5B is connected to pole 6b of a power source 6. Cables 5A and 5B consist of ingredients with little each of the cylindrical terminals 4a and 4b and the thermoelectrical conversion effectiveness, and a radiator is in a power source 6.
[0014] If pole 6b is used as a positive electrode, pole 6a is used as a negative electrode and an electrical potential difference is applied to a thermoelectric element, a current will flow in the direction of arrow-head A, and it will carry out endoergic between the N-type semiconductor component 4 and the P-type semiconductor component 3. Consequently, the semi-conductor wafer installed on installation side 2a can be cooled effectively, and that temperature can be controlled.
[0015] If pole 6b is used as a negative electrode, pole 6a is used as a positive electrode and an electrical potential difference is applied to a thermoelectric element, a current will flow in the direction of arrow-head B, and it will generate heat between the N-type semiconductor component 4 and the P-type semiconductor component 3. Consequently, the semi-conductor wafer installed on installation side 2a can be heated effectively, and that temperature can be controlled.
[0016] In the example shown in drawing 2 , the relay switch 8 and the load 7 are wired among Cables 5A and 5B. If a heating value is given by the bombardment of plasma ion to the semi-conductor wafer installed on installation side 2a, components 3 and 4 will work as a thermoelectric element. If a relay switch 8 is turned ON at this time, a current will flow like an arrow head A. Consequently, a heating value is consumed as power and a semi-conductor wafer is cooled.
[0017] Especially in the example of drawing 1 , there is an advantage that cooling and heating of a semi-conductor wafer are freely controllable, by controlling applied voltage. On the other hand, in the example of drawing 2 , self-electromotive force is used, if the current which flows a load 7 is measured, the temperature of a semi-conductor wafer is detectable from the magnitude of electromotive force, and if a base material 2 is heating, it can also cool.

[0018] As substantia-compacta ceramics which constitutes a base material 2, silicon nitride, alumimium nitride, sialon, silicon carbide, an alumina, a titania, etc. are desirable. Moreover, the ingredient of a thermoelectric cooling element is a Bi2Te3-Sb2Te3 system compound, a PbTe system compound, TAGS, Si0.8germanium 0.2, and FeSi2. A system compound and SiC A system compound etc. can be illustrated. Since especially FeSi2 and SiC can make the p-n junction component of a complicated configuration easily by the ceramic manufacturing technology, they are desirable.
[0019] A susceptor 1 can be manufactured by the following approach. First, as shown in drawing 3 , the ceramic base materials 9 and 10 after sintering, the P-type semiconductor component 3, and the N-type semiconductor component 4 are prepared. A base material 9 is the thing of a wrap sake about the front face of the P-type semiconductor component 3, and is plate-like. Crevice 10a which can hold semiconductor devices 3 and 4 is prepared in the base material 10, and projection 10b which can fit into through tube 4c is prepared.
[0020] And stick the N-type semiconductor component 4 to crevice 10a first, 10d of through tubes is made to penetrate cylindrical terminal 4b, and fitting of the projection 10b is carried out to through tube 4c. Subsequently, cylindrical terminal 3b is made to insert in through tube 10c, and plate-like section 3a is stuck to 4a. From besides, a base material 9 is carried and it joins. As for the junction approach, wax junction and glass junction are used. As for a semiconductor device, the thing of the product made from metal besides the sintered compact of a ceramic system, a print type thin film, etc. are used.
[0021] this invention person made the susceptor 1 as an experiment by the above-mentioned process, and conducted the actuation experiment. Namely, FeSi2 which doped manganese for the P-type semiconductor component 3 FeSi2 which formed and doped cobalt for the N-type semiconductor component 4 It formed. Each formed base materials 9 and 10 with silicon nitride. In silicon nitride, Y2O3 were added as sintering acid. 30% of the weight of Y2O3 and 30% of the weight of aluminum 2O3, and 30 SiO2 of weight %, and 10% of the weight of Si3N4 Base materials 9 and 10 were joined by heating at 1500 degrees C and forming oxy-night RAIDO glass using mixed powder.
[0022] A precise sintered compact is beforehand used for base materials 9 and 10 and P, and the N semiconductor devices 3 and 4, and although it is unifying, it is also possible to really sinter the Plastic solid of the ceramics. Furthermore, base materials 9 and 10 and the PN semiconductor devices 3 and 4 can also be formed with a spatter and a CVD method.
[0023] In addition, the situation which is carrying out solid-state contact is desirable, and endoergic and heating become important [unification] so that base materials 9 and 10 and the PN semiconductor devices 3 and 4 may not have a crevice in a junction interface and may be promptly performed between base materials 9 and 10 and the PN semiconductor devices 3 and 4. For this reason, the nearer possible one of the coefficient of thermal expansion of each ingredient is good. AlN When Si3N4 and SiC are used for base materials 9 and 10, SiC, SiGe of a semiconductor device, etc. are desirable.
[0024] And if it wires as shown in drawing 1 , the ZEBEKKU electric field E will arise by temperature-gradient deltaT of the junction interface of semiconductor devices 3 and 4, and a power source 6. E=alpha-deltaT. alpha is a Seebeck coefficient. For efficient thermoelectrical conversion, the large thing of performance-index Z=alpha 2 / K-P of the thermoelectrical matter is required. K and P show thermal conductivity and electrical resistivity respectively.
[0025] Pole 6b was used as the positive electrode, pole 6a was used as the negative electrode, and the direct current voltage of 100 V was applied. Consequently, the current of 5A flowed in the direction of arrow-head A, and the temperature of installation side 2a fell to -15 degrees C. In addition, the room temperature was 25 degrees C.
[0026] Moreover, it wired, as shown in drawing 1 , and pole 6b was used as the negative electrode, pole 6a was used as the positive electrode, and the direct current voltage of 100V was applied. Consequently, the current of 5A flowed in the direction of arrow-head B, and the temperature of installation side 2a rose to 65 degrees C. The room temperature was 25 degrees C.
[0027] Next, as shown in drawing 2 , it wired. Installation side 2a is heated with an infrared lamp

from the exterior, and it is temperature. It was made 800 degrees C. Temperature of the exoergic section of a circuit was made into the room temperature. When the relay switch 8 was turned ON and the whole cable was made into the closed circuit, the current of 5A flowed. By detecting the value of this current, whenever [stoving temperature] is detectable. Furthermore, after making a cable into a closed circuit, the temperature of installation side 2a after 1 minute It fell to 690 degrees C.
[0028] In the example of drawing 4 , the resistance heating element 11 was further laid under the interior of a susceptor 21. However, the same sign is attached to the same member as what was shown in drawing 1 and drawing 2 , and the explanation is omitted. The resistance heating element 11 which consists of a refractory metal is laid under the interior of a base material 2, and the cylindrical terminal 12 is connected to the edge of the resistance heating element 11. Lead wire 14 is connected to each cylindrical terminal 12, and lead wire 14 is connected to AC power supply 13.
[0029] And a semi-conductor wafer is installed through direct or other susceptors on installation side 2a, it energizes to the resistance heating element 11, and it is made to generate heat. When the temperature of a semi-conductor wafer has fluctuation, temperature is adjusted by the thermoelectric element.
[0030] In the example of drawing 5 , the relay switch 8 and the load 7 were connected to Cables 5A and 5B with laying the resistance heating element 11 under the interior of a base 2. Actuation of this part is the same as what was shown in drawing 2 .
[0031] Even if a semiconductor device is not a plane, the plane of composition of PN should just exist in a susceptor. In the situation which the component was installed only in the required place of cooling and heating, or the PN junction entered in the shape of a sinking comb, and is considered is sufficient.
[0032]
[Effect of the Invention] Since the thermoelectric element is laid underground in the base material which consists of substantia-compacta ceramics according to the susceptor of this invention as stated above, when there are receipts and payments of a heating value on a semi-conductor wafer, the temperature of a semi-conductor wafer can be controlled by operating a thermoelectric element.
[0033] And since the thermoelectric element is laid underground in the base material which consists of substantia-compacta ceramics, it is protected from the plasma gas for semi-conductor manufacture, and corrosive gas. Therefore, it continues at a long period of time, and the function which controls the temperature of a semi-conductor wafer is not spoiled. And it can be used satisfactory also under an elevated temperature and a high vacuum.

[Translation done.]